

PREPARING SPECIALIZED UNDERGRADUATE PILOT
TRAINING GRADUATES FOR F-35A TRAINING

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

PREPARING SPECIALIZED UNDERGRADUATE PILOT TRAINING GRADUATES FOR F-35A TRAINING, by Major Todd J. Lafortune, 79 pages.

In 2015, the USAF plans to start its first class of F-35A Initial Qualification Training (IQT) students immediately following their graduation from Specialized Undergraduate Pilot Training (SUPT). This class will signify the beginning of F-35A pilot production with a steady increase to over 180 F-35A pilots per year. These pilots will require certain skills to fly the F-35A and will be somewhat different from the skills required of today's fighter pilots as we move from fourth generation F-16, F-15, and A-10 aircraft to the fifth generation F-22A and F-35A. Without a major change in either how future fighter pilots train or the aircraft they train in the USAF will not be maximizing its combat effectiveness. Therefore, the current USAF fighter pilot training system from Initial Flight Screening through SUPT, Introduction to Fighter Fundamentals (IFF), and finishing with F-35A Formal Training Unit (FTU) might need to adapt in order to prepare these students for future combat operations. This study examines what skills might be required for future students entering F-35A FTU, determine whether the current system adequately trains them and if not make recommendations on how to mitigate the shortfall.

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ACRONYMS

ACC	Air Combat Command
AETC	Air Education and Training Command
BFM	Basic Fighter Maneuvers
CRM	Cockpit Resource Management
DEAD	Destruction of Enemy Air Defenses
FNA	Functional Needs Analysis
FTU	Formal Training Unit
HQ	Headquarters
HUD	Head-up Display
IFF	Introduction to Fighter Fundamentals
IQT	Initial Qualification Training
SEAD	Suppression of Enemy Air Defenses
SUPT	Specialized Undergraduate Pilot Training
USAF	United States Air Force

CHAPTER 1

INTRODUCTION

A 21 September 2009 *Air Force Times* article entitled “Pilot pipeline would delay specific tracks” notes that some United States Air Force (USAF) officials “argue students don’t have the skills to move directly from the T-38 to the new fighters, especially the F-22 and F-35, both single-seaters” (Roflsen 2009). In 2005, a RAND Corporation study entitled “Assessing the Impact of Future Operations on Trainer Aircraft Requirements” concluded, through interviews of Air Education and Training Command (AETC) instructor pilots at all phases of Specialized Undergraduate Pilot Training (SUPT), that “the T-38C provides adequate training for the undergraduate flying training skills students will need to prepare for future fighter aircraft” (Ausink et al. 2005, 49). So which opinion is correct?

This study examines the skills acquired in the current USAF fighter pilot training system and compares them to the expected skills for future students entering the F-35A Joint Strike Fighter Formal Training Unit (FTU). In 2015, the USAF plans to start its first class of F-35A Initial Qualification Training (IQT) students immediately following their graduation from SUPT (Kloos 2010). This class will signify the beginning of F-35A pilot production with a steady increase to over 180 F-35A pilots per year. These pilots will require certain skills to fly the F-35A and they will be somewhat different from the skills required of today’s fighter pilots as the USAF moves from fourth generation F-16, F-15, and A-10 aircraft to the fifth generation F-22A and F-35A. Therefore, the current USAF fighter pilot training system from Initial Flight Screening through SUPT, Introduction to Fighter Fundamentals (IFF), and finishing with F-35A FTU might need to adapt in order

to prepare these students for future combat operations. This study will examine what skills might be required for future students entering F-35A FTU, determine whether the current system adequately trains those skills and if not make recommendations on how to mitigate the shortfall.

This chapter presents a brief background of the USAF fighter pilot training system, states the primary and secondary research questions, lists the assumptions, definitions, limitations, delimitations, and describes the significance of the thesis.

Background

The USAF pilot training system has remained relatively constant since the early 1960s with one major change occurring in 1992. Throughout these years, the USAF attempted to make more changes in aircraft and training, but more often than not fiscal priority forced the USAF to keep pilot training relatively unchanged. With the introduction of fifth generation F-22A and F-35A aircraft, the USAF is experiencing the biggest technological advance in fighter aircraft since the introduction of the jet engine. The effect on pilot training is pilots will be transitioning from 1950s aircraft to the latest in stealth and avionics. Without a major change in either how future fighter pilots train or the aircraft they train in the USAF will not be maximizing its combat effectiveness.

A broad understanding of the USAF fighter pilot training system is necessary in order to comprehend how the USAF put itself in this position. Student pilots begin their journey in the initial flight-screening program. Over the years, this program changed to meet the needs of the USAF, but the objective of the program remained constant. The program introduces perspective pilots to basic flight and flying skills. It is a program designed to ensure the student not only has the basic skills needed to fly, but also to

ensure the student has the desire to commit to the 12-24 months of future training and careers as pilots. Once the student completes a short fourteen-sortie program, the student enters USAF pilot training.

USAF pilot training is a thirteen-month program with students accomplishing two phases of training, primary then advanced. Prior to 1992, all student pilots in generalized Undergraduate Pilot Training accomplished primary training in the T-37 jet aircraft then flew the T-38 jet aircraft in the advanced phase. Following graduation, students selected to fly fighter aircraft continued training in the T-38 in either Lead-In Fighter Training or more recently IFF. Today's IFF is a short nineteen-sortie program designed to prepare IFF graduates for their follow-on training assignments by introducing them to basic fighter pilot skills. After IFF students proceed to the FTU, where they fly their assigned fighter aircraft and learn the skills required to employ the aircraft for its assigned missions.

In 1992, Undergraduate Pilot Training began the transition to SUPT where students track to the T-38, T-1A, helicopters, or T-44 for the advanced phase. Towards the end of primary training, students tracked to the T-38 for the fighter and bomber pilots, the T-1A for large aircraft such as tankers and cargo aircraft, the T-44 for C-130 pilots, or the TH-67 for helicopters. After the advanced phase, future fighter pilots then move on to IFF in the T-38 prior to entering their respective FTUs. Focusing on the fighter training system, starting with the track decision to students entering the FTU, the USAF has not made any other major adjustments to the system despite major advances in aircraft performance and digital avionics technology.

Several studies have examined the need to change pilot training and/or buy new training aircraft since the 1970s. Of particular note, in 1977 the Air Staff supported a change to Undergraduate Pilot Training with a plan to purchase new aircraft to replace both the T-37 and T-38. The plan proceeded to the point where Air Training Command selected the T-46 as a replacement for the T-37. These plans halted when fiscal restraints forced the service to upgrade the T-37 to extend its service life (Ausink et al. 2005, 19). This is an example of where the USAF understood the need to upgrade the training aircraft, but fiscal priority forced the service to find innovative ways to use the existing aircraft.

Understandably, the USAF prioritizes the operational fleet that fights our wars over that of training aircraft. This resulted in continuously delaying the purchase of new, more capable trainer aircraft to manage training requirements for more technologically advanced operational aircraft. If unaddressed, the capabilities gap between operational and training aircraft will only worsen as the USAF's fighter inventory drastically changes over the next twenty years. In little over two decades, the USAF will retire most of their current inventory of fourth generation fighter aircraft and replace them with fifth generation F-22A and F-35A aircraft.

This dramatic change in the USAF's fighter inventory without a corresponding change to the training system or training aircraft has spawned debate on whether the service is prepared to train future fighter pilots to fly fifth generation aircraft like the F-35A. The purpose of this study is to compare the two sides of this argument and analyze the new data acquired from an F-22A lead-in program and the fact that the F-35A has started flying with complementary computer simulators. Some major issues

addressed will be information management, sensor fusion and management, flying with night-aided visual systems, and the effect of having no two-seat models of this high G-force fighter aircraft.

Primary Research Question

Does the current USAF fighter pilot training system and aircraft develop the required skills for future pilots to fly fifth generation fighters, specifically the F-35A Joint Strike Fighter?

Secondary Research Questions

1. What skills and proficiency levels do current student pilots acquire in SUPT and IFF prior to entering current fourth generation FTU?
2. What skills and proficiency levels will future student pilots acquire in the F-35A FTU?
3. Compared to current fighter aircraft, which missions and skills will F-35A pilots need to be proficient in during initial training?
4. What are some considerations for training a pilot in a single seat aircraft with no capability of training in a two-seat model like current fighter aircraft (except the A-10, which has no two-seat model)?
5. What are the similarities and differences in training an F-22A initial student pilot and an F-35A initial student pilot?

Assumptions

1. The T-38C will be used for both the advanced fighter track of SUPT and IFF until the Trainer-X replacement is funded and fielded.

2. SUPT will remain approximately 13 months for training with the fighter tracking decision made during the primary T-6 phase.

3. The F-35A will meet all the requirements contracted in the Operational Requirements Document.

4. The planned USAF buy will not be drastically cut from the approximate 1,763 aircraft. This assumption is based on Secretary of Defense, Robert Gates' decision to cut the F-22A and speed up delivery of the F-35A, as well as Secretary Gates' comments on relying on the F-35A as the primary tactical fighter. Purchasing this number of aircraft forces the USAF to mass produce pilots unlike the F-22A, which does not need to produce as many pilots with a planned buy of only 187 aircraft.

Definition of Terms

Avionics. A generic term referring to the aircraft's electronics. The electronics include communications, navigation, and sensors and the displays and management of these systems.

Core Competencies. A required skill and level of proficiency a student must attain prior to entering their Mission Qualification Training at their first operational assignment.

Develop the required skills. Refers to the average student having the minimum skills required to fly their first sortie in IQT as a solo pilot in command.

Familiar (as a core competency). Pilot has a basic knowledge of mission area and may make errors of omission or commission. Pilot is able to operate in a permissive environment and is able to handle some basic contingencies and unusual circumstances. A familiar pilot may need additional training prior to first competency tasking (Nelson 2007).

Introduced (as a core competency). Pilot has been introduced to the mission area during a sortie, a device, or academics but has not had any repetition to reinforce initial instruction. An introduced pilot will need additional training prior to first competency tasking (Nelson 2007).

Proficient (as a core competency). Pilot has a thorough knowledge of mission area and occasionally may make errors of omission or commission. Pilot is able to operate in a complex, fluid environment and is able to handle most contingencies and unusual circumstances. A proficient pilot is prepared for competency taskings without additional training (Nelson 2007).

Sortie. A term used to describe one aircraft's flight from takeoff to landing.

Tracked. The point in the primary phase of flight training that the student pilot learns what type of aircraft they will fly in the advanced phase of flight training. Students selected for T-38s will fly fighter, bomber aircraft, students selected for T-1As will fly tanker, cargo aircraft, students selected for T-44s will fly Turboprops, and some students will transition to helicopter training for helicopters.

Limitations

1. Since the F-35A airframe is still in research and development, proprietary Lockheed Martin information that will not be discussed.
2. Limited numbers of F-35A aircraft are currently flying and only by experienced Test Pilot Graduates so they are not representative of new student pilots.
3. This study will only address unclassified systems and capabilities.
4. There are no production aircraft or simulators currently fielded.

5. The number of inexperienced fighter pilots who have flown fifth generation fighter aircraft is limited, none have flown the F-35A.

Delimitations

1. This study will focus on student training starting with the T-38C advanced track and will not examine the T-6 primary training.

2. The study will rely on F-22A data since it is the only operational fifth generation fighter aircraft.

3. The study will focus on the F-16 and A-10 fourth generation fighter aircraft training in its comparisons to the F-35A.

4. The study will not consider United States Navy, United States Marine Corps, international partners F-35A or current fighter training.

5. The study will focus on IQT for recent SUPT graduates and not requalification training of experienced pilots.

Significance of the Thesis

The USAF's fighter aircraft inventory will drastically change in the next twenty years. The USAF will eventually replace most F-15C, F-16M, and A-10 aircraft with F-22A and F-35A aircraft. In order to make this a smooth transition the USAF must be proactive in changing the pilot training system to develop this new generation of fighter pilots. The USAF still has a few years before mass production of these pilots begins therefore the results of this study could have three distinct effects on the Air Force and potentially help the Air Force make informed decisions about the process and equipment used for future pilot training.

First, the information in this study will add more data to the debate and help the Air Force decide whether current aircraft in the training system can prepare students to fly the F-35A. The USAF decision to purchase a new training aircraft (referred to as Trainer-X) is pending, but this aircraft will not be operational until 2018 at the earliest and will not be available in significant numbers until 2020s. Therefore, the USAF must first determine whether the current trainer aircraft are capable of developing the necessary skills needed for fifth generation fighter pilots. If so, is the current system developing the necessary skills or should the system change to develop them with the current trainer aircraft? If not, what needs to change in order to acquire the necessary skills?

Second, if this study concludes the current aircraft cannot adequately prepare students to fly the F-35A, it will identify the skills required and recommendations on how to address the deficiencies prior to mass student production in the F-35A to include a possible set of requirements for the Trainer-X aircraft. Aircraft limitations in capabilities directly affect what an instructor can teach a student. The USAF's trainer aircraft, specifically the T-38C was designed and produced in the 1950s and 1960s. Upgrades to the airframe and avionics have improved its capabilities, but it does not have comparable avionics systems or energy management with even fourth generation aircraft such as the F-16. This capabilities gap leads to safety concerns with training new pilots. Mitigation in fourth generation fighter training is primarily with two seat versions the fourth generation aircraft allowing experienced instructor pilots to fly in the rear seat to monitor the student pilot. Therefore, this study will identify the skills needed prior to entering F-35A training

and recommend how to acquire these skills prior to training thru the use of different aircraft, simulators or changing the process.

Third, the information in the study will help the Air Force make informed decisions about future pilot training processes and requirements needed in training devices like simulators. As the Air Force faces training a new generation of fighter pilots it must examine all aspects of training and possibly change a few of its paradigms about training pilots. As with most aspects of life, times change and systems change; the Air Force might need to accept the fact that what was once important in training pilots might not be the priority anymore. The stick and rudder skills of flying an aircraft will always be considered essential in safely flying the aircraft, but advances in technology shorten the amount of flight time needed to acquire these skills possibly allowing the training system to re-allocate sorties to mission oriented tasks rather than basic flying tasks. In addition, advances in simulator technology might allow the USAF to transition some training tasks to the simulator instead of aircraft sorties. These are two examples of how training future fighter pilots might be different from the past and the USAF must keep an open mind and not always rely on lessons of the past.

CHAPTER 2

LITERATURE REVIEW

This study examines the skills acquired in the current USAF fighter pilot training system and compares them to the expected skills for future students entering the F-35A Joint Strike Fighter (F-35A) FTU. In 2015, the USAF plans to start its first class of F-35A IQT students immediately following their graduation from SUPT (Kloos 2010). This class will signify the beginning of F-35A pilot production with a steady increase to over 180 F-35A pilots per year. These pilots will require certain skills to fly the F-35A and they will be somewhat different from the skills required of today's fighter pilots as the USAF moves from fourth generation F-16, F-15, and A-10 aircraft to the fifth generation F-22A and F-35A. Therefore, the current USAF fighter pilot training system from Initial Flight Screening through SUPT, IFF, and finishing with F-35A FTU might need to adapt in order to prepare these students for future combat operations. This study will examine what skills might be required for future students entering F-35A FTU, determine whether the current system adequately trains those skills and if not make recommendations on how to mitigate the shortfall.

Since the 1950s, the advanced and IFF phases of USAF flight training relied on the T-38 with several upgrades through the years. This reliance on the T-38 and continuous advances in the operational fighter fleet stirred debate on how to better prepare student pilots for the new aircraft. The USAF continuously identified the need to either change the system or upgrade the equipment to keep up with the operational advances in technology and capabilities. Driving the final decision on how to address the need for change was the service's budget (Ausink et al. 2005, 19). Therefore, major

changes in pilot training focused on changing the training system with few changes made to the equipment. As the service begins to mass-produce F-35A pilots in one of the greatest technological advances in fighter aircraft, it may highlight the consequences of not addressing the need for new training equipment prior to the start of fifth generation fighter training.

The literature on this topic includes USAF sponsored studies and reports to articles in professional journals pertaining to pilot training and the future of pilot training. This study focuses on these sources for background information when framing the problem and relies on data from these sources to understand the USAF position on the topic. An important aspect of this study is the increase in knowledge about the flight characteristics and systems capabilities of the F-35A over the past five years with the maturation of the program. Previous studies of the pilot training system and the possible issues of fifth generation fighter training do not contain the new data collected over the past three years. Since then, the F-35A program developed a draft syllabus, developed core competencies for F-35A pilots, identified entry and exit criteria for F-35A IQT, developed a draft basic employment manual, and a group of core pilots have hundreds of hours of flight training device time and test pilots have over a hundred hours of flight time. This study analyzes these F-35A program documents as well as other USAF training documents to answer the primary and secondary questions presented in chapter 1 and make recommendations for the future. Included in this USAF literature is the graduation evaluation and after-action brief from a small test group of SUPT graduates who recently graduated from the F-22A IQT which included an additional lead-in

program after IFF to address some of the debated deficiencies. The rest of this chapter addresses some of these sources and how each will contribute to this study.

Assessing the Impact of Future Operations on Trainer Aircraft Requirements

In 2003, the USAF commissioned the RAND Corporation to “assess the impact of future operations on trainer aircraft requirements” (Devereaux 2008, 8). The product of the assessment was a 2005 report titled *Assessing the Impact of Future Operations on Trainer Aircraft Requirements*. The commissioning of this study highlights the USAF’s understanding that future flying operations might change how they train future students, but the USAF does not understand what capabilities they need in their trainer aircraft. Overall, the RAND study was “designed to help AETC and the USAF make informed decisions about retaining or replacing current trainer aircraft in order to best prepare pilots for the aircraft they will fly through the year 2040” (Ausink et al. 2005, iii).

The RAND report’s focus was not specifically for F-35A training or even fighter training. It examined the entire USAF pilot training system as well as all flying operations the USAF executes or anticipates it will execute in the future. This study focused on the fighter specific data and findings of the RAND report and applied them to future F-35A training. Overall, the RAND report presents a brief history of USAF pilot training and a description of why the USAF is facing this dilemma. The report then looks at what skills might be required of future pilots by analyzing individual pilot skills and the expected mission profiles in the future. An important part of this data is over 200 interviews with USAF pilots at every level of flight training. The data collected from these interviews is the basis for some of the RAND report’s conclusions; of note, none of

these pilots had flown fifth generation fighter aircraft and had to make assumptions when answering the surveys. After presenting the required skills the pilots might need, the report examines the adequacy of the T-38C and T-1A aircraft in providing a vehicle to teach these skills. Based on all of this data the RAND report concludes that the current system has the right focus and that the aircraft are adequate in training the skills required for future flying operations. Because of this conclusion, it states the decision to replace the current trainer aircraft is an economic decision and not a training decision. Therefore, the RAND report supports those who believe there is no training gap for future F-35A training or that it is insignificant and will not create any problems with training.

Advanced Pilot Training Functional Area/Needs Analysis

As part of the response to the RAND report AETC completed an initial Functional Area Analysis in March 2006 for Advanced Pilot Training. In April 2008, AETC completed an update to this analysis with another Functional Area Analysis for Advanced Pilot Training capabilities. Using these Functional Area Analysis' as a foundation, AETC completed a Functional Needs Analysis (FNA) for Advanced Pilot Training in August 2008. The purpose of the Functional Area Analysis' was to identify "tasks, conditions, and standards required for pilots to enter the Formal Training Units (FTUs) for the USAF's operational aircraft in 2018 and beyond" (Przybylski 2008, 2). Using these "tasks, conditions and standards" as the foundation for the FNA, the FNA assesses the capabilities needed to train pilots "in order to identify gaps, shortfalls, and redundancies" (Devereaux 2008, 7). Based on these "gaps, shortfalls, and redundancies,"

the USAF plans strategies to fill the gaps, mitigate the shortfalls, or minimize the redundancies.

The FNA accepts the RAND reports conclusion that the F-35A will not require new skills and the T-38C is adequate to train the skills required if the current pilot training system is continued, but the FNA highlights two major shortfalls in the current system. Specifically, Cockpit Resource Management (CRM) and basic stick and rudder flying skills will be more important in future aircraft. The F-35A will have no two-seat models possibly requiring AETC to develop a new approach to training CRM skills and ensuring more developed stick and rudder skills. Particularly, the FNA cites three specific tasks identified by the RAND report, which could affect training F-35A pilots. These tasks are sustained high-G flying, air-refueling, and flying with a night-aided visual systems like Night Vision Goggles or Distributed Aperture System. Using these three tasks as a starting point, the FNA accomplished a comprehensive analysis of pilot training using core tasks from the Universal Joint Task List, USAF Master Capabilities List, and the T-38 syllabus. Using these tasks, along with analysis of aircraft, training devices, missions, and the training system, the FNA made the conclusion there are gaps between the current training system and the FTU, but it does not specifically address the F-35A. Therefore, this study will rely upon the FNA and apply its conclusions to the F-35A training program.

F-22 After Action Report

In its conclusions, the above mentioned FNA identified twelve capability gaps in its fighter/bomber track of training and acknowledged that “some of these gaps are addressed by the F-16 “bridging” or F-22 Lead-in course (Devereaux 2008, 67), but the

FNA accomplished its analysis without data from this course. This Lead-in course is currently adapting, as more students progress thru the course, but it is an eight-sortie course in the F-16 for students entering the F-22 FTU following completion of IFF. The course introduces the students to the tasks and flight characteristics of a high performance fighter aircraft prior to entering F-22 FTU and their first solo flight in the F-22. The course was designed using information from the RAND report and fighter pilot experience in the USAF. The objectives of this program are to expose the students to several of the tasks highlighted in the FNA prior to flying the F-22 (Turner 2008, 9). After completion of the first two classes, AETC conducted After Action Reviews and subsequent reports to determine lessons learned. This study relies on these reports to glean instructor pilot views as well as the student's views on whether the course was needed, what needs to be included in the course, and whether a course should be formalized in the future fifth generation fighter pilot training system. Currently, there are no allocated funds for this course and AETC had excess training capacity to train these students because of the fighter force drawdown. If the USAF mandates this course for all F-22 and eventually F-35A students, the time for a decision is in the near future as mass production of F-35A pilots begins in 2015. AETC has collected data about the program and this study will rely on it to stress fifth generation training concerns.

USAF Documentation

The majority of the remaining literature for this study includes official USAF documentation to include syllabi, regulations, and official records. The information from this literature ranges from identifying levels of proficiency in specific flying skills to

what future F-35A pilots will encounter during future conflicts. The following identifies some of this documentation and highlights how it will contribute to this study.

This study will examine the T-38 advanced phase syllabus, IFF syllabus, and primarily the F-16 FTU syllabus to determine when AETC introduces certain flying skills and the level of proficiency required prior to entering the next phase of training. The study focused on the F-16 syllabus and not A-10/F-15E/F-15C and F-22A because the draft F-35A syllabus closely models the F-16 syllabus as both are single-seat, multi-role fighters. Specifically, the F-35A syllabus will have roughly the same number of sorties, number of training days, and focus on the same.

The F-35A proposed syllabus is under development by Lockheed Martin with the assistance of AETC as part of a Training Working Group. AETC has not approved even a draft syllabus of the initial FTU course, but the Training Working Group's analysis and data represents the best information on what the future syllabus will include. Therefore, this study relies upon this data to determine if the skills acquired in SUPT or IFF adequately prepare students for entry into the F-35A initial course. To facilitate this analysis this study also referenced the F-35A pre-Mission Qualification Training core competencies from Headquarters (HQ) Air Combat Command (ACC).

HQ ACC develops a document that states what core competencies an F-35A pilot must possess prior to entering training and after completing training. Core competencies include flying skills and mission areas for each pilot and a level of skill needed. Skill levels include highly proficient, proficient, and familiar. AETC defines each skill level in the document, which gives AETC a minimum standard to train each student during each phase of training (HQ AETC 2007b). Based on the entry core competencies, exit core

competencies, a set timeframe, and number of sorties allowed in the syllabus this study will analyze if the students will meet the entry core competencies and make recommendations for future training.

The development of the core competencies relied heavily upon lessons learned from the F-22 FTU and a group of core F-35A pilots. The USAF identifies several F-16, A-10, F-15E, F-15C, and F-22 pilots who spend time flying the F-35A training devices, developing F-35A tactics manuals and advising Lockheed Martin on aircraft and syllabus development. The author of this study was a core pilot for twelve months and relied on his personal experiences and the experiences of the entire group of core pilots in this analysis. This includes the opinions of these pilots and all documentation they produced in a proposed syllabus, tactics, and aircraft development.

In chapter 3, the author will discuss the methodology used in this thesis. The literature discussed in chapter 2 will help answer the primary question if the current USAF fighter pilot training system prepares future fighter pilots to fly the F-35A Joint Strike Fighter? This study will also identify the assumptions each of the above documents made and what affects these assumptions had on the documents conclusion and recommendations. Finally, the findings of this study will lead to conclusions and recommendations for changing the USAF fighter pilot training system or training aircraft, if warranted.

CHAPTER 3

RESEARCH METHODOLOGY

This study examines the skills acquired in the current USAF fighter pilot training system and compares them to the expected skills for future students entering the F-35A Joint Strike Fighter (F-35A) FTU. In 2015, the USAF plans to start its first class of F-35A IQT students immediately following their graduation from SUPT (Kloos 2010). This class will signify the beginning of F-35A pilot production with a steady increase to over 180 F-35A pilots per year. These pilots will require certain skills to fly the F-35A and they will be somewhat different from the skills required of today's fighter pilots as the USAF moves from fourth generation F-16, F-15, and A-10 aircraft to the fifth generation F-22A and F-35A. Therefore, the current USAF fighter pilot training system from Initial Flight Screening through SUPT, IFF, and finishing with F-35A FTU might need to adapt in order to prepare these students for future combat operations. This study will examine what skills might be required for future students entering F-35A FTU, determine whether the current system adequately trains those skills and if not make recommendations on how to mitigate the shortfall.

This chapter presents the research methodology the researcher used to answer the research questions in chapter 1. The chapter describes the general methodology used to collect information and the specific methodology used in answering the research questions to include the criteria used for comparing the current systems and aircraft to the future F-35A training system and airframe. The research involved a three-part process involving information collection, documentation review, and comparison. Lastly, the

chapter addresses the strengths and weakness of this methodology in answering the research questions.

Information Collection

Information related to the USAF pilot training system, training aircraft, and training devices is extensive and relatively easy to obtain. On the other hand, information related to the future F-35A training system, aircraft, and training devices is limited. In order to obtain the most recent and relevant information, information collection relied on three primary sources. First, correspondence and interviews with individuals working on the F-35A training system as well individuals at AETC working the current USAF fighter pilot training system produced source documentation for both programs used for background information and skills comparison. Second, research through the Combined Arms Research Library at Fort Leavenworth, Kansas, and Air University Library at Maxwell Air Force Base, Alabama, provided background information and professional opinions to both programs. Third, research on the internet also provided background information and professional opinions as well as official USAF training documents such as training syllabi. These three sources of information provided the starting point for the next phase in the research methodology of documentation review.

Documentation Review

Documentation review was the primary research method used in collecting background information and establishing the fact that the USAF has not decided whether there is a training gap for future F-35A flight training. Documentation review began prior to the researcher deciding to conduct this study. The researcher held the position of Chief,

Fifth Generation Flight Training at HQ AETC prior to beginning research for this study. This position included advising Lockheed Martin on developing the F-35A training system as part of the Training Working Group and being identified as an F-35A core pilot. Therefore, the researcher used this program experience as a foundation when collecting and reviewing documentation.

The researcher's knowledge of the F-35A training program and position in the USAF's training command, AETC, gave the researcher a unique perspective of possible F-35A training issues. The researcher identified similarities between F-22 training and future F-35A training. Therefore, the researcher began the documentation review with AETC source documentation on the development of the F-22 lead-in course to find possible similarities. This source documentation relied heavily on the 2005 RAND study so the researcher focused on the RAND study, its conclusions, assumptions, and recommendations to identify F-35A specific issues. Using this information as a foundation, the researcher focused on USAF source documentation, news articles, and professional journals to collect background information on why the USAF possibly finds itself unprepared for F-35A training and what the USAF leadership thinks about the situation.

The above documentation review established the possibility the USAF is unprepared for mass-producing F-35A pilots with its current training system. The next step in the documentation review focused on the current fighter pilot training system. The documents reviewed included syllabi, core competencies, and regulations related to the different phases of pilot training. This review identified the skills attained and proficiency

levels required prior to moving on to the next phase of training. Identifying these skills gave the study a baseline to compare future skills needed by F-35A pilots.

The next phase in the documentation review focused on the F-35A training system. There is no USAF approved final or draft syllabus representative of the future IQT syllabus and development of the training system remains in its beginning phases. Therefore, this study used interviews with F-35A core pilots, USAF documentation on future missions, F-22 similarities, as well as the F-35A source documentation to develop the expected skills of an F-35A pilot. Based on this group of expected skills and current instruction in the fighter pilot training system, the study transitioned to the next phase of research, comparing the different skills sets to identify the possibility of training gaps.

Skills Comparison

The final phase of research for this study was a comparative analysis of the skills currently taught in the fighter pilot training system to what F-35A student pilots need prior to entering FTU. This comparison focused on the current fighter training system starting with the advanced phase of pilot training in the T-38C. This study assumed the focus of primary training in the T-6 would not change because it involves all pilots and does not have a fighter focus. Therefore, the minimum baseline skill set acquired in T-6 training would remain constant even as the USAF fighter aircraft inventory changes over the next twenty years.

Using this minimum skill as a requirement for entering the advanced phase of training, this study analyzed when skills were introduced to students and the required level of proficiency in these skills the students must attain prior to entering the next phase of training. This analysis analyzed the T-38C advanced phase, IFF phase, and F-16 FTU

phase. The purpose of analyzing the F-16 FTU was to gain a better understanding of how the USAF ties SUPT to the FTUs and to ensure the F-35A training plan follows the same model as the other USAF fighter FTUs. This analysis identified the minimum skill set attained by current fighter pilots prior to entering their respective FTUs. Unless there is a dramatic change to the fighter training system within the ten years this study assumed the same skill set will not change for future F-35A student pilots prior to entering the FTU.

To determine whether this minimum skill set is sufficient for these pilots this study determined the expected minimum skill set required for F-35A pilots. Determining this skill set required identification of two sets of skills. First, this study identified the minimum required skill set for students to graduate the F-35A FTU. Second, this study identified the minimum required skill set for students prior to entering the F-35A FTU based on a time and resource constrained syllabus. This study assumes the F-35A FTU will mirror the F-16 FTU in numbers of sorties and duration for reasons outside the scope of this study. Based on this assumption there are a finite number of skills and level of proficiency a student will attain during FTU training. Therefore, identifying the minimum required skill set for graduation required this study to “reverse engineer” the minimum skills required for entry based on number of sorties, number of simulator events, and duration.

This study relied on four sets of information when determining the different skill sets mentioned in the previous paragraph. First, analysis by the F-35A Training Working Group identified a list of tasks they expect an F-35A pilot to accomplish while flying and employing the aircraft. Second, ACC identified the expected core competencies of each F-35A student pilot graduating from the FTU. Third, analysis of USAF doctrine and

future mission requirements to determine the expected flying environment F-35A pilots will encounter in the future. Fourth, interviews and correspondence with current F-35A core pilots who currently fly the F-35A training devices and develop F-35A employment documents based on the training device missions. Based on this information, this study determined the two skill sets mentioned above and facilitated the final analysis in this study.

The final analysis involved comparing the minimum skill set an F-35A must have prior to entering the FTU to the actual minimum skill set they acquired in the fighter training system. The purpose of this comparison was to determine whether there are gaps between the two, which the USAF must address prior to mass producing F-35A pilots. In determining whether the USAF must address these gaps, this study used safety of flight as the primary criteria and combat effectiveness as the secondary criteria. Safety of flight refers to unacceptable risk and placing the student in a situation where the average student making a reasonable mistake might still cause damage to the aircraft. Combat effectiveness refers to not developing the HQ ACC core competencies prior to F-35A FTU graduation. If a gap created a safety of flight issue then this study categorized it as a required skill prior to entering the F-35A. If a gap created a combat effectiveness issue, then this study examined where the training should be introduced and what level of proficiency is needed to exit that phase. Based on this analysis the study made conclusions and recommendations for the USAF of how to maximize training and ensure future F-35A pilots attain the skills required to safely employ the F-35A.

Strengths and Weaknesses

The strength in this study's research is in the wealth of knowledge on the USAF fighter training system. The USAF trained thousands of fighter pilots over the past sixty years and there is extensive data on the subject. In addition, because of the F-22 lead-in program, the USAF has some experience in training fifth generation fighter pilots and learned many lessons which can be applied to F-35A training. Therefore, the minimum skill set required to advance to the next level of training is based on the knowledge of thousands of fighter pilots and years of training experience unlike the data used to develop the F-35A skill sets.

The weaknesses in this study's research are the unknowns of the F-35A aircraft and training system. There are a limited number of pilots and even less aircraft currently flying. The F-35A core pilots and Training Working Group rely on the F-35A training devices and professional judgment in developing the training plan and expected mission profiles. In addition, the previous studies like the RAND study relied on the opinions of pilots who had not flown fifth generation fighter aircraft. They had to make assumptions when responding to surveys and interview questions. Therefore, the research examined other fighter training systems like the F-16 FTU to ensure the assumptions made for F-35A training were acceptable based on professional judgment.

Using the methodology described in this chapter along with the literature discussed in chapter 2, the study will present the findings in chapter 4. The findings will answer the primary and secondary research questions posed in chapter 1. Based on the findings this study will present conclusions on whether the USAF adequately prepares

student pilots for F-35A FTU and if not then this study will make recommendations on how to change the system to prepare future F-35A students.

CHAPTER 4

ANALYSIS

This study examines the skills acquired in the current USAF fighter pilot training system and compares them to the expected skills for future students entering the F-35A Joint Strike Fighter (F-35A) FTU. In 2015, the USAF plans to start its first class of F-35A IQT students immediately following their graduation from SUPT (Kloos 2010). This class will signify the beginning of F-35A pilot production with a steady increase to over 180 F-35A pilots per year. These pilots will require certain skills to fly the F-35A and they will be somewhat different from the skills required of today's fighter pilots as the USAF moves from fourth generation F-16, F-15, and A-10 aircraft to the fifth generation F-22A and F-35A. Therefore, the current USAF fighter pilot training system from Initial Flight Screening through SUPT, IFF, and finishing with F-35A FTU might need to adapt in order to prepare these students for future combat operations. This study will examine what skills might be required for future students entering F-35A FTU, determine whether the current system adequately trains those skills and if not make recommendations on how to mitigate the shortfall.

This chapter presents the analysis used to answer the research questions in chapter 1. The chapter starts with a description of the four major skill categories used to analyze the different phases of fighter pilot training. This description includes the justification for using these four categories and a broad definition of the skills included in each category. The chapter then presents the analysis of the different phases of fighter pilot training from entering the T-38C advanced phase to graduating from the F-35 FTU with respect to the four categories of skills. The analysis finishes with a comparison of

the F-22A training program and the F-35A. This comparison focused on the F-22A lead-in course and the similarities and differences between the F-22A and F-35A.

Four Skill Categories

This analysis categorized the different skills required to fly fighter aircraft into four categories: (1) stick and rudder skills, (2) airmanship skills, (3) CRM skills, and (4) fighter pilot skills. Grouping skills into these four broad categories made the task of identifying training shortfalls more manageable. For instance, the F-35A Training System Review Team identified over 3500 individual tasks associated with flying an F-35A (Lockheed Martin 2008) ranging from a takeoff to employing air-to-air missiles at night. Knowing the exact number of skills and the number of times a student performed a skill is not important. Identifying a type of skill and the proficiency level required in accomplishing that skill is what is important for this analysis. Therefore, this analysis grouped these tasks or skills into four categories based on USAF standards and previous research.

The basis for these particular categories originated from USAF checkride standards, the RAND study, and the fact the F-35A is a new fighter aircraft. First, USAF Form 8 checkrides evaluate pilots in their aircraft and determine the qualification level for the pilot (HQ USAF 2006). This includes qualified to fly the aircraft, instrument qualified, mission qualified, instructor qualified, and evaluator qualified. In all cases, the checkride evaluates the pilot's ability to fly the aircraft, i.e. their stick and rudder skills and evaluates their airmanship. Second, according to the RAND study, one characteristic of future flight operations will be a pilot's ability to process information and identify the source of information (Ausink et al. 2005, xv). In addition, the amount of information a

pilot receives in the cockpit will increase with advances in technology. Expectations are that the F-35A's capacity to receive information will be greater than any previous fighter aircraft and analyzing an F-35A pilot's CRM skills to handle this information is important for training these pilots. Lastly, flying fighter aircraft requires specific pilot skills and the F-35A skills will include differences as well as similarities with previous fighter aircraft competencies. This study analyzed the current fighter pilot training system with respect to these four categories. The following presents a more detailed description of each category and examples of some of the important skills encompassed in the category.

“Stick and Rudder” Skills

The term stick and rudder skills imply different things for each pilot even within the separate flying communities. The USAF Advanced Pilot Training FNA states “Stick and Rudder tasks address end-user required core competencies by ensuring pilots are proficient in basic and tactical piloting skills (physical control of the platform)” (Devereaux 2008, 13). This is further broken down into seven sub-tasks, but all revolve around performing flight tasks while maintaining aircraft control. Some argue there is a cognitive aspect to stick and rudder skills, but this study agrees with the USAF FNA which places cognitive skills in separate categories. Therefore, for the purpose of this analysis, stick and rudder skills refer to the *physical* skills required to fly the aircraft.

Completely separating cognitive thought from the act of flying is unrealistic, but the study categorizes a person's physical abilities to fly as stick and rudder skills. This includes those tasks that require hand-eye coordination or simply, physical coordination. Examples of such skills are takeoff, landing, aerobatics, altitude control, airspeed control,

and heading control, which all encompass maintaining aircraft control. Maintaining aircraft control includes cognitive thought, but a pilot with good stick and rudder skills has the physical ability to maintain aircraft control during all phases of flight.

Analysis of these skills during each phase of training took into account differences in aircraft and the need to adjust a pilot's stick and rudder skills for each aircraft. Using other fighter aircraft syllabi as a baseline, this study assumed a pilot would need the same approximate number of sorties and simulator events prior to their Instrument and Qualification checkrides.

Airmanship Skills

Merriam-Webster's dictionary simply defines airmanship as the "skill in piloting or navigating an aircraft" (2010). Air Force Instruction 11-2F-16 Vol. 2, *F-16 Aircrew Evaluation Criteria* considers airmanship a critical item meaning the pilot is either qualified (Q) or unqualified (U). The evaluation criteria are:

Qualified (Q). Executed the assigned mission in a timely, efficient manner. Conducted the flight with a sense of understanding and comprehension. Made appropriate decisions based on available information. Recognized the need for action. Aware of performance of self and other flight members. Aware of on-going mission status. Recognized, verbalized and correctly acted on unexpected events.

Unqualified (U). Decisions or lack thereof resulted in failure to accomplish the assigned mission. Mis-analyzed flight conditions and/or failed to recognize/understand mission developments, or demonstrated poor judgment to the extent that flight safety could have been compromised. Did not recognize the need for action. Not aware of performance of self and other flight members. Not aware of on-going mission status. Failed to recognize, verbalize and act on unexpected events. (HQ USAF 2006, 37)

Both the definition and evaluation criteria for airmanship are subjective and rely on experience to determine whether a pilot has good airmanship or not. What is hard to

argue is the importance the USAF places on airmanship by establishing it as a pass or fail item in determining a pilot's qualification. Therefore, for the purposes of this study, airmanship entails a professional responsibility to know, understand, and apply the rules, regulations, technical orders, flight manuals, tactics manuals, etc. in order to accomplish the mission or flight profile. It is important to note, this description includes the aspect of knowledge and using this knowledge in order to make appropriate decisions and take proper actions.

The complexity of a situation and the accompanying stress affects a pilot's ability to make appropriate decisions and take proper actions. Arguably, tactical training and combat missions are more complex than non-tactical missions. In addition, a single-seat fighter pilot does not have the support of a co-pilot to help make decisions and the final authority for all decisions rest with the one pilot in command. This is why airmanship is its own category even though there is an aspect of airmanship in the other three categories. The USAF cannot afford to ignore the fact there are no two-seat versions of the F-35A and developing a student pilot's airmanship is paramount to avoid tragedy. For these reasons, this study analyzes both tactical and non-tactical airmanship and how well the USAF fighter training system develops student's airmanship and if F-35A student pilots require more training.

Cockpit Resource Management Skills

Air Force Instruction 11-290 defines CRM as, "the effective use of all resources--people, weapon systems, facilities, equipment, and environment--by individuals or crews to safely and efficiently accomplish an assigned mission or task" (HQ USAF 2001, 8). In terms of this study, CRM skills are the skills required to manage all the resources

available to the pilot in their cockpit. These resources provide the pilot with an abundance of information so it is imperative for the pilot to manage what they are receiving, what it is telling them, and where it is coming from. The F-35A will receive information from on-board sensors as well as through data links from numerous outside aircraft and systems. Processing this information while maintaining aircraft control and keeping situational awareness is a difficult task requiring dedicated development prior to a their first F-35A sortie.

CRM includes tasks other than information and sensor management, but this study focused on this specific aspect of CRM because of the incorporation of advanced technology in the F-35A. The F-35A will have more sensors and will receive more information than previous generations of fighter aircraft, complicating CRM for student pilots. A key component of information and sensor management is prioritization. Prioritization includes knowing when to use a sensor, weapon, or information. Therefore, this study focuses on what sensors and how much information a student pilot receives in each phase of training and how well it prepares them for the F-35A.

Fighter Pilot Skills

Fighter pilot skills may or may not be unique to fighter aircraft, but they are necessary to accomplish the assigned task or mission. Examples include use of Night Vision Goggles or night-aided visual systems such as the Distributed Aperture System in the F-35A, formation flight, and performing an anti-G straining-maneuver. Whether fighter aircraft specific or not, there are skills an F-35A pilot must acquire at some point in training that directly impact their ability to fly the fighter aircraft and effectively employ it. The following example illustrates a fighter pilot skill: current fighter and non-

fighter aircraft fly in formation of two or more aircraft, but have the ability to continue the mission with only one aircraft. For the F-35A, there will be missions requiring information sharing between two or more aircraft; therefore, the pilot needs some level of proficiency in formation flight making it a required fighter pilot skill.

This study broke fighter pilots skills into two sub-categories, mission-oriented, and individual skills. Mission-oriented skills are those skills required to accomplish the different tactical missions an F-35A will fly. Examples of the twelve core missions of the F-35A are air interdiction, suppression of enemy air defenses/destruction of enemy air defenses (SEAD/DEAD), offensive counter-air, defensive counter-air, Strategic Attack, and Close Air Support (Davis 2006). Some of the skills required to accomplish the air-to-air specific missions include Basic Fighter Maneuvers (BFM), Air Combat Maneuvers, Tactical Intercepts, and Air Combat Tactics. Some of the skills required to accomplish the air-to-ground specific missions include weapons delivery, target sensing, and cueing. The second sub-category of fighter pilot skills is individual skills. These skills derive from the fact that the F-35A is a single-seat aircraft with no two-seat trainer versions. This study focused on skills required to mitigate the risk of having no two-seat aircraft. The most significant of these skills are flying a sustainable high-G force aircraft, flying with night-aided visual systems, and air-to-air refueling.

The remainder of this chapter analyzes how each phase of the current fighter pilot training system addresses or instructs each of the four categories introduced above. The analysis began by establishing a baseline skill set based on the primary phase of SUPT. Using the primary phase objectives and analysis of the different phases of training the study determined what skills each student pilot acquires prior to entering the advanced

phase of training or the fighter pilot training system. The next step was applying each category of skills to the three phases of fighter training; advanced phase in the T-38C, IFF in the T-38C, and initial FTU training in the F-35A. The study analyzed each phase separately and applied all four categories to each phase in order to answer the research questions in chapter 1 and lead to conclusions and recommendations for chapter 5.

T-6 Primary Phase

The T-6 primary phase of SUPT is a seven-month training course for all USAF student pilots, which determines the track a student pilot enters, eventually leading to their assigned operational aircraft. Student preference, their level of performance, and instructor's judgment all play a role in the track decision. The T-6 Joint Primary Pilot Training syllabus, dated November 2009, establishes the performance standards for the course and is the primary source of information for the remainder of this section.

The T-6 primary phase of training includes 326.5 hours of ground/academic training, 45 aircrew training device sorties, and 65 aircraft sorties spread through four phases that include several night sorties. The four phases are contact, instruments, formation, and navigation. The contact phase teaches students the basics of flying utilizing the T-6 to include aerobatics, stall recoveries, basic visual flight procedures, and traffic pattern work to include solo flights. The instrument phase includes all aspects of instrument flying from instrument maneuvers including steep turns to several instrument approaches. The formation phase includes flying as part of a two-ship formation of aircraft and performing basic maneuvers as part of the two-ship. The final phase is navigation and focuses on enroute procedures between two points. All phases end with a student category checkride, evaluating student abilities and ensuring they met minimum

standards. These checkrides are not USAF Form 8 checkrides, meaning the students never become qualified or rated T-6 pilots.

The T-6 syllabus consists of 65 aircraft sorties and 45 aircrew training devices sorties with the overall objective of:

- Prepar[ing] graduates of this phase for the advanced phase and for future responsibilities as military officers and leaders. This training includes:
- a. Flying training to teach the principles and techniques used in operating in advanced aircraft.
 - b. Ground training to supplement and reinforce flying training.
 - c. Officer development training to strengthen the graduate's leadership skills, officer qualities, and understanding of the role of the military pilot as an officer and supervisor. (HQ AETC and Chief Naval Air Training Command 2009, 1)

Each of the four phases and each sortie has its own specific objectives, but all support the overall objective of preparing the student for the advanced phase of training. The objectives of a phase help determine the minimum grading standard on individual tasks and the overall grading standard for the category in order for the student to continue to the next phase of training. The grading standard is Excellent (E), Good (G), Fair (F), or Unsatisfactory (U). The syllabus states the "Standards equate directly to the grade scale of Good unless stated otherwise" (HQ AETC and Chief Naval Air Training Command 2009, 14). The syllabus defines good as "The student performs the operation, maneuver, or task satisfactorily. Deviations occur which are recognized and corrected in a timely manner" (HQ AETC and Chief Naval Air Training Command 2009, 13). Assuming these objectives and grading criteria do not drastically change over the next ten years, a potential F-35A student will enter the advanced phase having met the minimum standard on all tasks and skills introduced. A key point to note is these objectives and grading criteria do not have the specific goal of developing just fighter pilots. The goal is to develop a base skill set for all students, even those tracking to the T-1A, helicopter, or

T-44. Based on this information the following presents the baseline for the four skills categories.

Stick and rudder skills apply throughout all phases of training, but the contact phase's primary focus is on these skills. Generally, almost every task in the contact phase except for most aerobatics must meet a good standard. In addition, students solo for the first time during this phase highlighting the importance of acquiring good stick and rudder skills. Therefore, the T-6 primary phase provides the starting point for developing the stick and rudder skills required of an F-35A pilot.

Airmanship skills also apply throughout all phases of training and are always a primary focus. There is not a specific task called "airmanship," that must be graded on every sortie or in each phase, but the overall grade encompasses the airmanship aspect of this study. Instructors use a relative grading scale to assess the student's overall performance on the sortie using the same grading standard mentioned above. This allows an instructor's experience and intuition to judge a student's airmanship skills in tasks like simulated Emergency Procedures, adherence to flight rules, and decision making to name a few. Most of these airmanship skills include an aspect of safety and require a grade of good. Therefore, the T-6 primary phase also provides the starting point for developing the airmanship skills required of an F-35A pilot.

Like airmanship, CRM applies throughout all phases of training and is always a primary focus. Compared to the F-35A and numerous operational aircraft, the T-6 does not have any sensors and the amount of information requiring processing is minimal. Plus, most sorties have an instructor in the cockpit to assist the student if they become task saturated with the information processing. There are several graded areas

encompassing CRM such as cross-check and task management. Most of these skills require a good standard, but task management only requires a grade of fair during the formation phase. This means the student is safe, but makes mistakes detracting from performance (HQ AETC and Chief Naval Air Training Command 2009, 13). Therefore, the T-6 primary phase introduces and develops some CRM skills needed to fly most aircraft, but it does almost nothing to prepare potential F-35A student pilots for managing sensors and processing large amounts of information.

Lastly, the formation phase introduces some fighter pilot skills, but the focus is on formation flight for all aircraft and not fighter specific. The phase introduces the basics of two-ship aircraft formations, but does not include any of the mission-oriented skills described above. Of note, only 50 percent of the individual formation skills require a good standard to include the anti-G straining-maneuver and the remainder requires a fair. Therefore, the T-6 primary phase develops some individual fighter skills, but it does nothing to prepare potential F-35A student pilots for mission-oriented skills.

The important point to highlight is the T-6 primary phase currently meets its objectives of preparing all students for the advanced phase of training, but when examining the development of F-35A pilots, the T-6 primary phase, understandably, does not address all aspects of their development.

T-38C Advanced Phase

The advanced phase of SUPT begins at the eight-month point of training and includes student pilots selected for fighter aircraft. All students entering the advanced phase have met the minimum requirements for the primary T-6 phase of training and continue their training in the T-38C for the next six months. The T-38C Specialized

Undergraduate Pilot Training syllabus, dated August 2009, establishes the performance standards for the course and is the primary source for the remainder of this section.

The T-38C advanced phase of training includes 288.3 hours of ground/academic training, 30 aircrew training device sorties, and 82 aircraft sorties spread through four phases that include several night sorties. The four phases are transition, instruments/navigation, formation, and low-level navigation. The transition phase focuses on transitioning to the T-38C and adapting to the different characteristics of this airframe. The tasks evaluated are similar to the contact phase of T-6s, but students fly them in a faster jet aircraft to include solo flights. The instrument/navigation phase includes all aspects of instrument flying to include navigation from point to point. Similar to the contact phase, this phase mirrors the T-6 instrument and navigation phases, but combines them and focuses on T-38C specifics. The formation phase includes flying as part of two and four-ship aircraft formations and introduces maneuvers that are more complex as part of the formation. The final phase is low-level navigation and focuses on procedures and navigation in the low-level airspace structure down to 500 feet above the ground. The transition and formation phases end with a student category checkride, the instrument/navigation phase ends with both an instrument and navigation checkride, and the low-level navigation phase does not include a checkride. The checkrides evaluate student abilities and ensure they met minimum standards. These checkrides are not USAF Form 8 checkrides, meaning the students never become qualified or rated T-38C pilots, but they do graduate with the USAF aeronautical rating of pilot.

The T-38Cs overall objective is to:

Qualify students for the USAF aeronautical rating of pilot and entry into follow-on training courses. Provide all foundation skills essential for success as combat aircrew members, military officers, and leaders. Specifically, course graduates are proficient in:

- a. operating a high-performance jet aircraft in terminal and enroute airspace.
- b. flight planning and conducting flight operations under Instrument or Visual Flight Rules to include day / night IFR operations in the terminal and enroute environment. Have limited proficiency in low-level operations as a single-ship or as lead / wing in a 2-ship formation.
- c. conducting a mission profile in a defined area. Be able to understand and exploit handling characteristics of high-performance jet aircraft.
- d. visual patterns and landings (HUD [Heads Up Display] ON and HUD OFF). Have limited proficiency in emergency procedure landings (HUD ON and HUD OFF).
- e. control and performance concept of instrument flying.
- f. instrument procedures to include instrument takeoff, departure, enroute procedures, enroute descents, RNAV operations, and instrument approaches.
- g. formation procedures and operations to include:
 - (1) all formation rejoins to #2, #3, or #4 formation positions.
 - (2) the use of pursuit curves to manage closure, aspect, and range; or to maintain a formation position.
 - (3) leading a formation to and from the areas and executing a mission profile in a defined area.
 - (4) 4-ship formation procedures and operations (limited proficiency).
- h. solo single-ship and 2-ship operations.
- i. task management, situational awareness, risk management / decision-making, CRM, and emergency procedures required to safely and effectively accomplish the mission.
- j. the understanding of aircraft systems capabilities, aircraft directives, AFIs [Air Force Instructions], and local procedures and demonstrate proficiency in applying procedures from all applicable source guidance. (HQ AETC 2009c, 1)

Each of the four phases and each sortie has its own specific objectives, but all support the overall objective of qualifying the student for entry into follow-on training. The objectives of a phase determine the minimum grading standard on individual tasks and the overall category grading standard in order for the student to continue to the next phase of training. The grading standard is Excellent (E), Good (G), Fair (F), or

Unsatisfactory (U). Like the T-6 primary phase the training standard is good unless stated otherwise. The definition of good remains the same with the addition of “without verbal prompting from the instructor” (HQ AETC 2009c, 13) to correct a deviation. Assuming these objectives and grading criteria do not drastically change over the next ten years, a potential F-35A student will enter IFF having met the minimum standard on all tasks and skills introduced. Based on this information the following presents a breakdown of how the focus of this phase changed compared to the primary phase followed by the analysis for each of the four skills categories.

Comparing aircraft sorties and aircrew training device sorties in the T-6 syllabus to the T-38C illustrates how the T-38C focuses more on fighter specific tasks and skills. Combining aircraft sorties and training device sorties into one category (sorties) equates to 110 sorties for the T-6 and 112 sorties for the T-38C. The T-6 syllabus allocates 49 sorties or 44 percent to the contact phase, 46 sorties or 42 percent to the instrument/navigation/low-level navigation phases, and 15 sorties or 14 percent to the formation phase. The T-38C syllabus allocates 39 sorties or 35 percent to the transition phase, 40 sorties or 36 percent to the instrument/navigation/low-level navigation phases, and 33 sorties or 29 percent to the formation phase. As previously stated, airmanship and CRM skills are a primary concern in all phases of training, but the contact/transition phase focuses on the stick and rudder skills and the formation phase on more fighter pilot skills. The decrease in allocation for the contact/transition and instrument/navigation/low-level phases from T-6 to T-38C highlights a shift in training focus from stick and rudder skills to fighter pilot skills.

Stick and rudder skills apply in all phases of training, but the transition phase's primary focus is on these skills. The training philosophy for this phase is to "emphasize normal and Emergency Procedure (EP) VFR [Visual Flight Rules] patterns and landings, AHC[Advanced Handling Characteristics], stalls, acclimation to the high-G environment, understanding and controlling high-performance fighter aircraft, and basic instrument procedures and approaches" (HQ AETC 2009c, 41). The student must apply the basic flying skills they acquire in the T-6 to a new aircraft that has similar flight characteristics as their future fighter aircraft. In addition, students must solo in this phase, demonstrating ability to develop stick and rudder skills for a high-performance aircraft. Lastly, the grading standard for most of the tasks in this phase is a good except for most aerobatic maneuvers and a select few simulated Emergency Procedures that require a grade of fair. Therefore, the T-38C advanced phase is a good test of a student's ability to continue their development towards flying an F-35A.

Airmanship skills also apply during all phases of training and are a primary focus in all phases. Similar to the T-6, there is not a specific task called "airmanship," that must be graded on every sortie or in each phase; the overall grade encompasses the airmanship aspect of this study. Instructors use a relative grading scale to assess the student's overall performance on the sortie using the same grading standard mentioned above. This allows an instructor's experience and intuition to judge a student's airmanship skills across all phases of flight from engine start to engine shutdown. This subjective grading criterion allows for an overall assessment of student airmanship to accomplish the mission in a safe manner, even if they had deviations on specific airmanship tasks. At the completion of T-38C training, students receive their wings and the USAF aeronautical rating of pilot

validating the student has the necessary level of airmanship to continue and become an operational pilot. Therefore, the T-38C advanced phase adequately continues the development of airmanship skills for future F-35A pilots.

Like airmanship, CRM applies throughout all phases of training and is always a primary focus. Compared to the F-35A, the T-38C lacks sensors and the amount of information that needs processing increases, but it is not as complex as either fourth or fifth generation fighter aircraft. By having the student fly more solo sorties, fourteen total with eight in the formation phase, the syllabus attempts to develop some single-seat CRM skills. This study placed any task that increased the amount of information a single-seat fighter pilot must process into the CRM skills category. There are several graded areas which encompass CRM such as visual clearing, task management, wingman consideration, and risk management, all requiring a good standard. Therefore, the T-38C advanced phase adequately continues the development of some information based CRM skills needed to fly most aircraft, but lacks the complexity to prepare potential F-35A student pilots for managing sensors.

Lastly, the formation phase introduces more individual fighter pilot skills including minimal exposure to a single mission-oriented skill. The phase continues the basics of two-ship aircraft formations/maneuvers and introduces four-ship aircraft formations/maneuvers. Students also perform an extended trail exercise, which involves maneuvering in relation to another aircraft, a skill required in several mission-oriented areas, most notably BFM, and Air Combat Maneuvers, but this is the only mission-oriented skill introduced. Most individual fighter skills must meet a good standard stressing the importance of the continued development of these skills, a major change

from T-6 training. Finally, there is a major emphasis on the anti-G straining-maneuver because the T-38C has a higher G force capacity and student pilots fly more solo sorties. Therefore, the T-38C advanced phase continues development of some individual fighter skills, but it only introduces one mission-oriented skill limiting the development of potential F-35A student pilots.

Introduction to Fighter Fundamentals Analysis

IFF is an eight to ten week course following SUPT graduation designed to prepare fighter pilots for their follow-on assignment to the F-15C, F-15E, F-16, F-22A, or A-10. Students entering IFF met the minimum requirements for the T-38C advanced training and they continue their training in the T-38C for this eight to ten week course. The course is broken down into tracks A-E depending on the student's follow-on aircraft with each track having different requirements. The USAF Introduction to Fighter Fundamentals (IFF) T-38C syllabus, dated January 2009 with Change 1 September 2009, establishes the performance standards for the course and is the primary source for the remainder of this section.

On average, IFF includes 80 hours of ground/academic training, eleven-aircrew training device sorties and 21 aircraft sorties spread across three basic phases: formation/advanced handling characteristics, air-to-air, and air-to-ground. The number of sortie types within in each phase depends on the students track. This study focused on track B, the multi-role track, designed for F-15E and F-16 pilots. Each phase has its own specific objectives, but all support the overall objective:

To graduate pilots and weapon systems officers (WSO) with a basic understanding of fighter fundamentals. The emphasis is on developing wingman responsibilities, situational awareness, judgment/decision making, and crew

coordination/flight integrity. Commanders should graduate only those students who have demonstrated the potential to complete fighter training in an increasingly complex environment. Students who reach the limits of their ability in the tasks introduced in IFF should not continue in the fighter training program. (HQ AETC 2009d, 1-1)

Two key points of this objective are the system no longer focuses on basic flying skills, it is a specialized course, and instructors must assess a student's potential and decide if they have reached their limit and cannot handle flying high-performance aircraft.

Assessment of the student's performance and potential is slightly different from the primary and advanced phases of training. IFF course training standards are "the ability of the student to perform the specific mission tasks and defines the minimum overall performance levels required to complete this course" (HQ AETC 2009d, 2-5). The grading associated with these standards are Unknown (U), Dangerous (D), and zero to four with zero being lack of ability and four being high degree of ability. The minimum grade for each tasks ranges from one to two except critical Emergency Procedures, which requires a three. In general, any task involving previously acquired basic flying skills, safety of flight tasks, and some new fighter skills requires a grade of two, described as "Performance is almost correct. Makes errors that impact mission/task effectiveness, but recognizes and corrects them" (HQ AETC 2009d, 2-6). In addition, several of the newly introduced fighter skills require a grade of one, described as "Performance is safe, but indicates limited proficiency. Needs IP [Instructor Pilot] assistance to correct errors" (HQ AETC 2009d, 2-6). Assuming these objectives and grading criteria do not drastically change over the next ten years, a potential F-35A student will exit IFF having met the minimum standard on all tasks and skills introduced. The following section presents a brief description on the intent of each phase within IFF

to establish a better understanding of the overall course followed by an analysis of the IFF syllabus focusing on how much development a student receives in the four skills categories.

The formation/advanced handling phase consists of only five aircraft sorties and “is intended to teach the student typical formations and squadron standards used by fighters as well as the flight discipline required of a fighter pilot. The advanced handling sortie should introduce the student to ‘max performing’ the aircraft as required during basic fighter maneuvers (BFM)” (HQ AETC 2009d, 5-2). This phase only introduces a few new tasks and focuses on getting the students flying again and practicing the skills they acquired in SUPT.

The air-to-air phase is ten sorties and the intent “is to teach the student the basic principles of BFM while flying against a restricted bandit from short and medium range perch setups. Emphasis should be on universal principals vice T-38 specific training” (HQ AETC 2009d, 5-8). This phase is the start of dedicated fighter training. It is the first time students perform fighter specific skills and must display some ability and potential to fly high-performance fighter aircraft. Even with the focus on fighter skills, the syllabus emphasizes continued evaluation on formation and instrument skills with students maintaining a minimum proficiency in each.

The air-to-ground phase is four sorties and the intent “is to gain student proficiency in range procedures, range patterns, achieving weapons delivery parameters, safe escape, and error analysis” (HQ AETC 2009d, 5-17). With only four sorties dedicated to this phase, the focus is not only employing the aircraft in a tactical manner, but on safely flying the aircraft in its air-to-ground role. Similar to the air-to-air phase,

this phase emphasizes continued evaluation on formation and instrument skills with students maintaining a minimum proficiency in each.

Stick and rudder skills are not the primary focus in any phase of IFF and the expectation is students know how to fly the T-38C and will maintain a minimum proficiency level throughout the course. If a student regresses in a task, the task must return to standards on the next sortie or the student may have to re-fly a sortie or be assigned additional ground training. In addition, two sorties, one air-to-air and one air-to-ground, have an option for the student to fly solo, highlighting the importance of maintaining proficiency in the basic skills. This continuous assessment of stick and rudder skills ensures students not only continue developing the necessary skills to fly high-performance aircraft through practice, but maintain them as they progress through the system and on to future F-35A training.

Airmanship skills also apply throughout all phases of training and continue to be a primary focus in all phases of IFF. The introduction of tactical scenarios in IFF challenges a student's airmanship ability at a different level. Not only does the student have to maintain the basic airmanship they developed in SUPT, they must adhere to range procedures and properly perform exercise and fight set-ups, all while executing complex tactical maneuvers in accordance with USAF training rules. Evaluation of the student's ability to display the required airmanship skills to meet this challenge while accomplishing the tactical mission occurs throughout the course and is a necessary step in the development of future F-35A pilots.

Like airmanship, CRM applies throughout all phases of IFF and is always a primary focus. Since the students continue to fly the T-38C, there is no development of

sensor management skills, but the amount of information the student processes in these tactical scenarios increases. In the air-to-air phase, students must assess their adversary and maneuver to exploit any advantage by positioning themselves in a weapons engagement zone. In the air-to-ground phase, students must monitor the members of their flight while adhering to the range procedures and maneuver their aircraft into a position to employ weapons. Evaluation of the student's ability to perform these tasks helps in the on-going development of information processing, but the aircraft lacks the sensors to prepare potential F-35A student pilots for managing them.

Per the course objective, developing basic fighter pilot skills is the focus of the IFF syllabus. The primary focus is on individual fighter skills with minimal exposure to mission-oriented skills. The syllabus emphasizes safe employment of a high-performance aircraft through constant assessment of the anti-G straining-maneuver, but there is still no exposure to air-to-air refueling or flying with night-aided visual systems. IFF introduces more mission-oriented skills, but it is still minimal compared to what they receive in the FTU. Students fly ten air-to-air BFM sorties and four air-to-ground range sorties. Both are building block tasks to develop mission-oriented skills and the syllabus strives to instruct "universal principles" (HQ AETC 2009d, 5-8) which apply to all fighter aircraft. Therefore, IFF's focus on the development of more individual fighter skills prepares potential F-35A pilots for the FTU, but it does almost nothing to prepare them for mission-oriented skills.

Overall Analysis of Skills Acquired in SUPT through IFF

Overall, the current fighter pilot training system adequately prepares student pilots in some areas of the four categories listed above and does not have the capability to

train other areas. This study determined the training addresses all four categories, but the system develops stick and rudder and airmanship skills more than the CRM and fighter pilot skills. Awarding students the USAF aeronautical rating of pilot confirms they are proficient in flying an aircraft and have good stick and rudder skills. In addition, the stick and rudder challenges of flying the 1960s era T-38C may be more difficult than flying the fifth generation F-35A. Becoming a pilot also confirms they have the necessary level of airmanship skills to fly a high-performance aircraft with the potential to fly fighter aircraft. The IFF syllabus specifically evaluates potential and, “Students who reach the limits of their ability in the tasks introduced in IFF should not continue in the fighter training program” (HQ AETC 2009d, 1-1). This criterion implies the T-38C cannot challenge the student’s airmanship to the level of a fighter aircraft meaning there is a training shortfall with respect to developing airmanship skills for fighter FTU.

There are also training shortfalls in information and sensor management, the two primary CRM skills this study analyzed. Sensor management is elementary based on aircraft limitations so the development of these skills cannot occur. Developing the ability to prioritize and process information occurs throughout training with a steady increase in the amount of information a student must process, but it does not compare to the amount of information an F-35A pilot will receive. While the current fighter training system attempts to develop this skill, it is lacking for future F-35A pilots. Lastly, there is a training shortfall in developing fighter pilot skills, especially in the mission-oriented category. There is an attempt to develop individual fighter pilot skills. The system maximizes what it can accomplish given aircraft limitations, but cannot replicate air-to-air refueling and flying with night-aided visual systems, both major concerns for a single

seat pilot. In addition, the number of tactical mission's increases with each new generation of aircraft and the current system does not develop any mission-oriented skills that would assist the student in their FTU.

The remainder of this chapter focuses on F-35A training and the related skills required prior to entering the FTU. The study used the proposed F-35A syllabus, ACC directed F-35A pilot core competencies, opinions of F-35A core pilots, and lessons learned from the F-22 lead-in program to develop this skill set to make conclusions and recommendations for the research questions from chapter 1.

F-35A Analysis

There is no approved F-35A IQT syllabus although it is under development. The exact timeframe for an approved syllabus is unknown; with recent media reports of the USAF delaying Initial Operational Capability the syllabus will undoubtedly change before the first IQT class. Therefore, this study obtained information from HQ, AETC on the Training System Review Team syllabus development and not an approved syllabus. The Training System Review Team is a group of experienced fighter pilots from the USAF, United States Navy, United States Marine Corps, and international partners from several fighter backgrounds along with representatives from Lockheed Martin. Based on their experience and F-35A simulator sorties, the IQT will produce an approved syllabus prior to the first class whenever that takes place so the information in this study will change over the next few years. Finally, some information in the syllabus under development is non-releasable outside the F-35A program; in order to keep this study unclassified and releasable this study does not discuss specifics of the proposed syllabus.

An understanding of the restrictions in developing a syllabus helps frame the problem faced by the Training System Review Team. For reasons outside the scope of this study, the F-35A IQT syllabus must remain within a seven to eight month timeframe. Using HQ AETC's twenty average training days per month, there is a limit to how many training events, defined as ground/academic training, training device sorties, or aircraft sorties, a student can perform in the seven to eight month timeframe. Compounding the issue is the daily restrictions placed on students, including number and combination of events allowed per day and pilot restrictions (crew rest and the twelve-hour duty day). Comparing the syllabus of the multi-role, single-seat F-16 to the proposed F-35A syllabus highlights the challenges faced by Training System Review Team in developing the first fifth generation multi-role fighter syllabus.

The syllabi are similar in they have four major phases, approximately the same number of ground/academic training hours and aircraft sorties, equal course length (seven to eight months), and both fly similar types of missions, but the F-35A syllabus contains about forty percent more training device sorties and trains two additional mission areas. The F-16 syllabus consists of four major phases designated transition, air-to-air, air-to-surface, and night systems. The missions associated with these phases are instruments, advance handling, transition, BFM, Tactical Intercepts, Air Combat Maneuvers, Air Combat Tactics, low-altitude, basic surface attack, Surface Attack Tactics, Close Air Support, and night systems which includes air-to-air and air-to surface sorties (HQ AETC 2008b, 1-3 thru 1-5). The F-35A syllabus consists of four major phases designated transition, air-to-ground, air-to-air, and mission. The missions associated with these phases are familiarization, instruments, formation, basic air-to-ground, low-altitude,

armed reconnaissance, Close Air Support, Tactical Intercepts, BFM, Air Combat Maneuvers, Air Combat Tactics, SEAD/DEAD, and strike with night sorties mixed flown in most phases (Lockheed Martin 2007). Adding armed reconnaissance and SEAD/DEAD to the F-35A syllabus adds training to an already limited timeline resulting in less training in other mission areas. The increase in training device sorties also strains the timeline, but illustrates the shift in training some skills in training devices instead of the aircraft and illustrates the concern of having no two-seat aircraft.

Determining the skills required to meet the graduation criteria is a significant aspect of developing any flying syllabus. One input used by HQ AETC in syllabus development is ACC's required core competencies. The list of core competencies ranges from basic skills like mission planning to broad categories like situational awareness. Based on a HQ AETC briefing titled, "Core Competency Development Summit Outbrief," the capability levels for F-16 pilots are proficient, familiar, and introduced (Nelson 2007). The F-35A core competencies document uses the same capability levels as the F-16, so this study assumed their definitions apply to the F-35A since both originate from the same ACC directorate, ACC/A3. Developing a syllabus with the goal of acquiring core competencies ensures a student achieves the capability levels required in each task if time is not a factor. For the F-35A, time is a major factor, so the question is whether it is possible for an F-35A student pilot to attain the ACC directed core competencies in a seven to eight month course based on their skills and proficiency level at the start of IQT.

In order to analyze the core competencies in relation to the four skill categories, this study grouped each individual core competency into one of the four categories. Not

to be confused with the four skills categories of this study, there are six major categories of core competencies with individual tasks listed under each of the six categories. The six major categories are basic attributes/supporting, general aircraft operations, sensor operation and employment, air-to-ground, air-to-air, and SEAD/DEAD (HQ AETC 2010). Grouping the individual competencies into a respective skill category resulted in five stick and rudder, twelve airmanship, eight CRM, and forty fighter pilot competencies or skills. Not surprisingly, this distribution focuses on training students in employment of their aircraft or fighter skills while improving on the base stick and rudder, airmanship, and CRM skills they developed prior to the IQT.

With only five core competencies directly related to stick and rudder skills the expectations are the students acquired most of these skills prior to the IQT and only require minimal exposure in the F-35A to become proficient. The F-35A proposed syllabus allocates approximately seven sorties to the transition phase, to prepare them for their eighth sortie, an Instrument/Qualification checkride, which qualifies them as a rated F-35A pilot, but not combat pilot. Prior to this sortie, students also fly seventeen training device sorties, unlike the F-16 students who fly nine sorties, attempting to mitigate the concern of no two-seat aircraft. After the checkride, students are required to maintain their stick and rudder skills through continuous evaluation; regression will result in the student re-flying the sortie. Overall, the combination of previous training, successful completion of the checkride, and constant evaluation of skills make it feasible to achieve the F-35A core competencies that correspond to stick and rudder skills.

Airmanship applies throughout every phase of the syllabus, but they are basic skills every pilot must have to accomplish every mission. Similar to stick and rudder

skills, the checkride validates the level of airmanship of qualified F-35As pilot in instrument and non-tactical flying missions. The expectation is they continue developing their airmanship skills throughout the course and graduate with a proficient capability level to accomplish most assigned missions. The core competencies reflect this by grouping all but three of the airmanship skills into either the basic attributes/supporting competencies or general aircraft operations competencies and require a proficient level. The three remaining skills are SEAD/DEAD core competencies and two of the three only require a familiar capability level. Specifically mentioning airmanship skills in SEAD/DEAD and requiring only a familiar capability level is a product of students having never flown this type of mission (HQ AETC 2010). Compared to the F-16 syllabus, the F-35A expects to train students in the same timeframe, but introduce additional mission areas including SEAD/DEAD and armed reconnaissance. Accepting a familiar capability level in SEAD/DEAD competencies compensates for these factors, but other skills may suffer. Therefore, the F-35A proposed syllabus develops the basic airmanship skills needed to fly the F-35A through the combination of previous training, successful completion of the checkride, and continuous airmanship development, but may lack in developing the airmanship levels needed to accomplish each assigned mission.

The core competencies address the development CRM skills in a similar manner as the airmanship skills needed to accomplish tactical missions. Up until F-35A training, students had no exposure to sensor management and the limitations of aircraft capabilities and mission profiles minimized the amount of and need to manage information. Therefore, developing required skills to the directed capability level must occur in F-35A training. The proposed syllabus addresses this shortfall with the increase in required

training device sorties. The core competencies also address the shortfall by making sensor operation and employment its own major core competency category with five associated tasks. Of the eight total CRM competencies, seven need a proficient capability level and one a familiar level. Tasks requiring a proficient capability level include task management/prioritization, overall CRM, sensor management/prioritization, cueing management/prioritization, radar employment, and datalink employment. The one task requiring a familiar capability level is degraded sensor operations in an electronic attack environment. Overall, the combination of emphasizing sensor management throughout the course with its own core competencies and the increase in the number of training device sorties, the F-35A IQT attempts to develop the required CRM skills, but the lack of development prior to the IQT will challenge the average student.

With forty core competencies related to fighter pilot skills, the F-35A IQT's major focus addresses the development of these skills. Minus the sensor operation and employment category, every category has some fighter pilot tasks with the basic attributes/supporting and general aircraft operations competencies focusing on individual fighter pilot skills and air-to-ground, air-to-air, and SEAD/DEAD competencies focusing on the mission-oriented skills. In addition, twenty-eight tasks require a proficient capability level and twelve a familiar level. In general, only new or advanced employment tasks require the familiar capability level. Therefore, based on the core competencies and using the F-16 course objective as a guide, the course objective for the F-35A IQT might state, "produce qualified F-35A pilots with basic proficiency in air-to-air and air-to-ground mission tasks and limited proficiency in SEAD/DEAD and night mission tasks."

Adding SEAD/DEAD mission-oriented skills to the syllabus, as compared to the F-16 syllabus, in conjunction with maintaining a seven to eight month syllabus implies there is less development of other skills. In order to add the three SEAD/DEAD missions, the proposed F-35A syllabus eliminates three or four basic air-to-air sorties. Several of the F-35A core pilots described a dual reason for eliminating these sorties. First, a paradigm shift is occurring in the importance of particular fighter pilot skills; the F-35A core pilots assisting in the development of the syllabus are relying on the aircraft being easier to fly than previous aircraft requiring fewer sorties to attain the same proficiency level (Kloos 2010). In today's world of advanced technology and trends away from human operators, it may mean a fighter pilot's basic skills lay in managing the technology and not in maneuvering the aircraft or it may mean flying the aircraft is considerably easier than in the past, allowing the pilot to focus on managing the technology. Regardless, the proposed F-35A syllabus acknowledges this shift; the IQT will develop the required mission-oriented skills and proficiency level based on future developments.

The development of individual fighter skills varies from mission-oriented skills due to the absence of a two-seat aircraft. Flying approximately sixty aircraft and seventy training device sorties develops student's individual fighter pilot skills in employing the aircraft to the required capability levels. The major shortfalls revolve around whether students should fly an estimated 95 million dollar aircraft solo while never having flown in a nine G-force flight regime, never performed air-to-air refueling or flown with a night-aided visual system. These are required individual fighter pilot skills and with no plans to produce two-seat versions of the F-35A, the proposed syllabus almost doubles

the number of training device sorties flown prior to the first flight. Even with these additions, the risk to students is too great to consider the system adequate. Therefore, until more F-35A aircraft fly and mass production of students occurs allowing acceptable risk for the USAF, the proposed F-35A syllabus does not adequately develop the average student in these three individual fighter skills prior to flying the respective sortie type.

Overall, the proposed F-35A training addresses all of the core competencies and related skills required of future F-35A pilots, but the analysis reveals several shortfalls and one major shortfall. First, the proposed syllabus adequately develops all of the stick and rudder, and most of the airmanship skills. Specifically, most airmanship related core competencies require a proficient capability level and the average student will attain this level in basic airmanship tasks. Displaying this level of airmanship in all tactical missions is unreasonable because of the limited numbers of sorties for each mission. Second, the proposed syllabus adequately develops most of the CRM, but the lack of development prior to F-35A training might challenge the average student. Specifically, increasing training device sorties and dedicating a major core competency to these skills addresses the challenge, but it might not be enough to develop a proficient capability level. Third, the proposed syllabus adequately develops most fighter pilot skills, but the lack of a two-seat aircraft highlights a major shortfall. Specifically, the training develops all mission-oriented related core competencies to the required capability and would develop all individual related core competencies if there were a two-seat aircraft. The major shortfall is adequately preparing a student to fly solo for sustained high G-force flights, air-to-air refueling operations, and flying with the Distributed Aperture System. In addressing this

shortfall, the F-35A training system needs to examine the F-22A IQT syllabus, which also faced the same challenge.

F-22 Lead-In Analysis

The only fifth generation fighter aircraft in which student pilot training is occurring is the USAF F-22A. In December 2005, the USAF announced Initial Operational Capability for the F-22A and it was over two years before the USAF trained four students in the F-22A IQT. The reasons for the delay do not apply to this study, but the actions taken to prepare these students are relevant to training F-35A student pilots. The major USAF decision was these four students must perform certain tasks in a two-seat fourth generation fighter aircraft with an instructor pilot present prior to entering the F-22A IQT. Using the F-16 as the platform, the F-22A lead-in program consists of eight sorties in order “to mitigate single-seat training risks to include: high-G training, Air-to-Air Refueling, and side-stick transition familiarization” (Love 2009a). The initial After Action Brief also recommended adding Night Vision Goggle sorties to the syllabus as a lesson learned from the initial class (Turner 2008, 15). Analyzing this program and applying the lessons learned to the F-35A helps ensure the USAF makes informed decisions on how to best train student pilots.

The USAF decision to develop the F-22A lead-in program resulted from training shortfalls highlighted in the same RAND study, “Assessing the Impact of Future Operations on Trainer Aircraft Requirements,” described and analyzed in chapter 2. The major shortfall mentioned by the study was the USAF’s “ability to prepare SUPT graduates for the transition to 5th Generation Fighter like the F-22 . . . comprised of technology shortfalls in the T-38C as well as inherent safety concerns about the lack of a

dual-seat version of the Raptor” (Love 2009a). Addressing these shortfalls, HQ AETC developed two programs, the lead-in program mentioned above as well as a new track in IFF focusing on more air-to-air training, the primary role of the F-22A, but this program does not relate to the F-35A. The remainder of this analysis focuses on the lessons learned and opinions of the instructors and students as presented in the After Action Briefs/Reports.

The After Action Report and associated briefs reviewed the entire lead-in program to include administration of the course, ground/academic training, and aircraft sorties. Students as well as instructor pilots from both the F-16 and follow-on F-22A provided inputs and recommendations.

Collection of student inputs occurred immediately following the lead-in program and a few months after starting the F-22A IQT. The follow-up inputs allowed HQ AETC to assess how beneficial the program was from the student’s perspective by having them compare the two aircraft. Three of the inputs received directly relate to the previously mentioned training shortfalls. First, the students all agreed the “BFM sorties and exposure to AAR [air-to-air refueling] was excellent” (Turner 2008, 15) in preparing them for the F-22A. Not only did the program expose them to sustained high-G maneuver and air-to-air refueling, it gave them confidence in performing these tasks prior to executing them solo in a more expensive F-22A. Second, students thought the “course should be conducted in CCIP [Common Configuration Implementation Program] modified F-16s” (Turner 2008, 15). Common Configuration Implementation Program modified F-16s include the Helmet Mounted Cueing System and Link-16 datalink giving the F-16 more sensors and ability to receive more information. Flying the entire course in these aircraft

would give the students more exposure to sensor and information management better preparing them for the F-22A. Third, the students thought adding Night Vision Goggles to the course would benefit them in the F-22A training (Turner 2008, 15). All three of these inputs help justify the benefits of having the lead-in program and mitigating the risk of having no two-seat aircraft.

Instructor pilots from both aircraft agreed with student inputs and unanimously agreed the course was a huge success. The F-16 instructors requested the addition of training sensor formations to the students. Sensor formations are a relatively new fighter formation where the wingmen remain in formation with sensors like datalink instead of visually. In addition, the F-16 instructors recommended, “the last sortie be an initial solo including a tanker for solo air refueling” (Turner 2008, 9). Both of these recommendations reiterate the benefits of the program and support the overall objective of exposing the students to certain tasks prior to the IQT. The F-22 instructor’s opinion best sum up the benefits of the program. They believe the student’s development is excellent and they had no significant training issues with respect to the tasks trained in the lead-in program (Turner 2008, 17).

This chapter provided analysis on four training programs in an attempt to answer the secondary research questions presented in chapter 1. Comparing the answers to those questions, the following chapter will answer the primary research question, make recommendations for the USAF, and provide areas for further research.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This study examined the skills acquired in the current USAF fighter pilot training system and compared them to the expected skills for future students entering the F-35A Joint Strike Fighter (F-35A) FTU. In 2015, the USAF plans to start its first class of F-35A IQT students immediately following their graduation from SUPT (Kloos 2010). This class will signify the beginning of F-35A pilot production with a steady increase to over 180 F-35A pilots per year. These pilots will require certain skills to fly the F-35A and they will be somewhat different from the skills required of today's fighter pilots as the USAF moves from fourth generation F-16, F-15, and A-10 aircraft to the fifth generation F-22A and F-35A. Therefore, the current USAF fighter pilot training system from Initial Flight Screening through SUPT, IFF, and finishing with F-35A FTU needs to adapt in order to prepare these students for future combat operations. This study examined what skills might be required for future students entering F-35A FTU, determined whether the current system adequately trains those skills, and made recommendations on how to mitigate the shortfall.

This chapter presents the conclusions of this study by answering the primary research question from chapter 1 and recommends future research topics pertaining to the F-35A training system. This study grouped the required skills of future F-35A pilots into four categories, determined if the current fighter pilot training system introduces them, and determined what level of proficiency the students acquire. Then the study determined if the proposed F-35A FTU continues development of these skills and is sufficient in developing the required ACC directed Core Competencies. Based on the analysis on both

training programs, this study determined whether there is a training shortfall between graduating the last phase of the current system, IFF, and entering the next phase, F-35A FTU. In other words, can today's average IFF graduate realistically acquire the required core competencies in the proposed F-35A syllabus or is there a training shortfall between IFF and F-35A FTU.

Conclusions

Does the current USAF fighter pilot training system and aircraft develop the required skills for future pilots to fly fifth generation fighters, specifically the F-35A Joint Strike Fighter? This study determined that the current system and aircraft do not adequately develop the required skills for future F-35A student pilots entering the FTU. This shortfall does not apply to all the required skills and focuses mainly on aspects of flying a single-seat fighter aircraft and the advances in technology providing pilots with more sensors and information to manage. The current system does adequately develop the non-fighter specific skills required of all pilots and must continue even with the differences in fifth generation fighter training. The remainder of this section presents the conclusions for each of the four categories and identifies the training shortfalls in each.

Stick and Rudder skills are the basic skills every pilot must attain as they progress through training. Every aircraft requires slightly different skills to maintain aircraft control, but the foundation developed in T-6 training adequately develops every pilots stick and rudder skills. In the T-38C advanced phase, students continue developing the required skills, but focus more on fighter specifics, which adequately develops every fighter pilots stick and rudder skills. Finally, the primary focus of IFF is on developing other fighter skills because the students are rated pilots and have attained the required

skills to graduate IFF, but must continue developing them through practice. This baseline skill is more than adequate for the average student entering the F-35A with the expectation they will meet the stick and rudder core competencies required by ACC upon graduation. Therefore, there are no training shortfalls in the development of stick and rudder skills between the current fighter pilot training system and the proposed F-35A training plan.

Airmanship skills are the other skill set the current fighter pilot training system adequately develops. Evaluation of a pilot's airmanship begins the day they enter initial flight screening and does not end until they finish their career. The pass or fail criteria for airmanship on the USAF Form 8 checkride highlights the importance placed on these skills. To develop these skills, the USAF focuses on airmanship throughout all phases of training and expects students to accept more responsibility with experience. This is especially true for fighter pilots, as most will fly single-seat aircraft requiring a high level of airmanship. As fighter pilots progress through training, the missions become more complex requiring a higher level of airmanship that instructors continuously evaluate. Beginning primarily in IFF, instructors must evaluate the student's potential in flying fighter aircraft and based on this subjective criterion of airmanship students may not continue in the fighter pilot training system. Therefore, there are no training shortfalls in the development of airmanship skills between the current fighter pilot training system and the proposed F-35A training plan.

CRM skills are one of the two categories that contain training shortfalls and expecting an average student to acquire the required skills prior to F-35A graduation is unrealistic. Flying any aircraft requires a pilot to accept information and process it in

order to make the appropriate decision and subsequently take the proper action.

Advancements in technology and the addition of sensors on aircraft increases the amount of information a pilot must process and manage. The current system does not adequately develop the skills to accomplish this task primarily due to aircraft limitations. The T-6 is a relatively new aircraft, but has no sensors and its focus is in developing a basic skill set for all pilots and not in developing a fighter pilot's ability to manage sensors. The T-38C is an old aircraft with no sensors that tried to address some information management tasks through upgrades, but does not have the capabilities to increase information flow and challenge the students. Therefore, the students enter F-35A training with no sensor management skills and limited information management skills requiring most CRM skill development to occur in the F-35A training program. Expecting an average student to develop these skills in the limited time available to the F-35A FTU is unrealistic and creates a training shortfall.

The biggest training shortfall between the current fighter pilot training system and the F-35A FTU occurs in developing fighter pilot skills. First, developing certain fighter pilot skills prior to accomplishing them in a single-seat aircraft creates a safety related training shortfall. Like the F-22A, the F-35A program will not produce any two-seat aircraft. Without a lead-in program, students will transition directly from a T-38C to an F-35A. The T-38C is a high performance aircraft, but does not have comparable flight characteristics and systems to the F-35A. Specifically, the F-35A will sustain higher G-force loads, have the capability to air-to-air refuel, and have a Distributed Aperture System to aid the pilot's vision during night flights. Two-seat aircraft would help mitigate the inherent risk of each of these, but the F-35A does not have this option. Second,

compared to the multi-role F-16 syllabus, the proposed F-35A syllabus adds armed reconnaissance and SEAD/DEAD to the training plan. Adding more missions to a time limited syllabus forces a re-allocation of air-to-air sorties to these new missions. The result is students cannot acquire the same proficiency level as previous fighter pilots creating more risk for their future operational units. Therefore, adequately preparing students for their first high-G force flight, first air-to-air refueling attempt, and first Distributed Aperture System sortie at night are the biggest training shortfalls between the current fighter pilot training system and the proposed F-35A training plan.

Recommendations

The author recommends further study and possible changes in several areas each related to the four skills categories. First, a study dedicated to analyzing the basic stick and rudder skills required of future pilots. As technology continues to improve the flight characteristics and capabilities of aircraft, the amount of effort required to maintain aircraft control while employing its capabilities might decrease. A part of this study should include an analysis of shifting some training earlier in the system in order to eliminate the shortfalls highlighted in this study.

Second, the addition of more student solo sorties in both the T-38C advanced phase and the IFF phase of the current fighter training system. Solo sorties give the student's confidence in their ability and challenges them to display the level of airmanship required of fighter pilots. If they do not successfully meet this challenge then the USAF can eliminate them prior to starting the F-35A FTU.

Third, certain tasks should continue to shift from aircraft sorties to training device sorties. Students must safely execute all tasks while flying the aircraft at some point in

the syllabus, but the introduction and early development of some CRM skills should occur in training devices. Training device sorties are less expensive and the ability to focus on specific tasks like sensor management without the stress of everything involved with flying is invaluable.

Finally, until a significant number of pilots fly the F-35A and determine it is safe for IFF graduates to execute the previously mentioned profiles, the USAF must mitigate the risk of flying a 95 million dollar single-seat aircraft. Efforts to replace the T-38C with the Trainer-X are ongoing at HQ AETC and must address these shortfalls when developing the requirements document. The major issue with this program is it will not be operational prior to the first F-35A IQT students. With no major changes to the trainer aircraft in the next eight years, the USAF must mitigate this risk through a change in the system. Development of a program similar to the F-22A lead-in is necessary to address the major training shortfalls of preparing pilots under the current fighter pilot training system for their future F-35A training.

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